(1390 REV. 5-93) US DEPT. OF COMMERCE PATENT & TRADEMARK OFFICE

ATTORNEY DOCKET NUMBER
110723

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (if known, sec 37 C.F.R.1.5)
09/937567

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FR00/00946	April 12, 2000	April 12, 1999

TITLE OF INVENTION
INTEGRATED HEATING AND COOLING DEVICE IN A REACTOR FOR THERMAL TREATMENT OF A SUBSTRATE

APPLICANT(S) FOR DO/EO/US
Pierre DUCRET, Herve GUILLON

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)

6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.

8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. ☒ A FIRST preliminary amendment.

    ☐ A SECOND or SUBSEQUENT preliminary amendment.

14. ☐ A substitute specification.

15. ☒ Entitlement to small entity status is hereby asserted.

16. ☐ Other items or information:

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.5) 09/937567	INTERNATIONAL APPLICATION NO. PCT/FR00/00946	ATTORNEY'S DOCKET NUMBER 110723

17. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National fee (37 CFR 1.492(a)(1)-(5)):		
Search Report has been prepared by the EPO or JPO $860.00		
International preliminary examination fee paid to USPTO (37 CFR1.482) $690.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $710.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO.....$1,000.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) .....$ 100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	18 - 20 =	0	X $ 18.00	$	
Independent Claims	2 - 3 =	0	X $ 80.00	$	
Multiple dependent claim(s)(if applicable)			+ $270.00	$	
TOTAL OF ABOVE CALCULATIONS =				$860.00	
Reduction by 1/2 for filing by small entity, if applicable.			-	$430.00	
SUBTOTAL =				$430.00	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 month from the earliest claimed priority date (37 CFR 1.492(f)).			+	$	
TOTAL NATIONAL FEE =				$430.00	
				Amount to be refunded	$
				Charged	$

a. ☒ Check No. 123200 in the amount of $430.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Director is hereby authorized to charge any additional fees which may be required, or credit any overpayment, to Deposit Account No. 15-0461. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
OLIFF & BERRIDGE, PLC
P.O. Box 19928
Alexandria, Virginia 22320

Date: September 27, 2001

NAME: William P. Berridge
REGISTRATION NUMBER: 30,024

NAME: Thomas J. Pardini
REGISTRATION NUMBER: 30,411

(1390 Rev.10-00)

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Pierre DUCRET, Herve GUILLON

Application No.: US National Stage of PCT/FR00/00946

Filed: September 27, 2001 Docket No.: 110723

For: INTEGRATED HEATING AND COOLING DEVICE IN A REACTOR FOR THERMAL TREATMENT OF A SUBSTRATE

PRELIMINARY AMENDMENT

Director of the U.S. Patent and Trademark Office
Washington, D. C. 20231

Sir:

Prior to initial examination, and after entry of the Annexes to the IPER, please amend the above-identified application as follows:

IN THE TITLE:

Please replace the title as follows:

INTEGRATED HEATING AND COOLING DEVICE IN A REACTOR FOR THERMAL TREATMENT OF A SUBSTRATE

IN THE ABSTRACT:

Please add the Abstract as attached hereto.

IN THE CLAIMS:

Please replace claims 5 and 8 as follows:

5. (Amended) The heating and cooling device according to claim 1, characterized in that it comprises additional heating means (58) arranged facing the substrate (14) opposite the cooling box (26) to provide a second heating by radiation.

8. (Amended) A thermal treatment furnace having a reaction chamber wherein a substrate is positioned, characterized in that it comprises a heating and cooling device according to claim 1.

Please add new claims 10-18 as follows:

--10. The heating and cooling device according to claim 2, characterized in that it comprises additional heating means (58) arranged facing the substrate (14) opposite the cooling box (26) to provide a second heating by radiation.--

--11. The heating and cooling device according to claim 3, characterized in that it comprises additional heating means (58) arranged facing the substrate (14) opposite the cooling box (26) to provide a second heating by radiation.--

--12. The heating and cooling device according to claim 4, characterized in that it comprises additional heating means (58) arranged facing the substrate (14) opposite the cooling box (26) to provide a second heating by radiation.--

--13. A thermal treatment furnace having a reaction chamber wherein a substrate is positioned, characterized in that it comprises a heating and cooling device according to claim 2.--

--14. A thermal treatment furnace having a reaction chamber wherein a substrate is positioned, characterized in that it comprises a heating and cooling device according to claim 3.--

--15. A thermal treatment furnace having a reaction chamber wherein a substrate is positioned, characterized in that it comprises a heating and cooling device according to claim 4.--

--16. A thermal treatment furnace having a reaction chamber wherein a substrate is positioned, characterized in that it comprises a heating and cooling device according to claim 5.--

--17. A thermal treatment furnace having a reaction chamber wherein a substrate is positioned, characterized in that it comprises a heating and cooling device according to claim 6.--

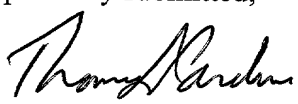
--18. A thermal treatment furnace having a reaction chamber wherein a substrate is positioned, characterized in that it comprises a heating and cooling device according to claim 7.--

REMARKS

Claims 1-18 are pending. By this Preliminary Amendment, an abstract is added, claims 5 and 8 are amended to eliminate multiple dependencies and claims 10-18 are added to compensate for material deleted from claims 5 and 8. Prompt and favorable consideration on the merits is respectfully requested.

Attached is the Abstract and an Appendix which includes marked-up copies of the title and each rewritten claim (37 C.F.R. §1.121(c)(1)(ii)).

Respectfully submitted,



William P. Berridge
Registration No. 30,024

Thomas J. Pardini
Registration No. 30,411

WPB:TJP/zmc

Attached:
ABSTRACT
APPENDIX

Date: September 27, 2001

OLIFF & BERRIDGE, PLC
P.O. Box 19928
Alexandria, Virginia 22320
Telephone: (703) 836-6400

DEPOSIT ACCOUNT USE AUTHORIZATION
Please grant any extension necessary for entry;
Charge any fee due to our Deposit Account No. 15-0461

ABSTRACT

A heating and cooling device for a substrate 14, comprising an electric heating resistor 16 which is integrated into notches 18 in the plate 12 with an inner covering 22 exhibiting good thermal conductivity placed therebetween. A cooling box 26 is arranged opposite the plate 12 and can be displaced between a first position that is spaced by means of a gap 32 in the lower surface of the plate 12 during the heating phase when the resistor 16 is supplied with power and a second near position when it comes into contact with the lower surface during cooling of the plate 12. The cooling box 26 is provided with a superficial sheet 30 of compressible material exhibiting good thermal conductivity to ensure homogeneous thermal contact with the lower surface of the plate 12. The notches 18 of the plate 12 are separated from each other by intermediate transverse members 20 that are used as calorific transfer means when the cooling box 26 is in the second near position. The invention can be used in thermal treatments of substrates or samples.

APPENDIX

Changes to Title:

The following is a marked-up version of the amended title:

INTEGRATED HEATING AND COOLING DEVICE ~~INTEGRATED~~ IN A REACTOR FOR THERMAL TREATMENT OF A SUBSTRATE

An Abstract is Added.

Changes to Claims:

Claims 10-18 are added.

The following are marked-up versions of the amended claims:

5. (Amended) The heating and cooling device according to claim 1~~one of the claims 1 to 4~~, characterized in that it comprises additional heating means (58) arranged facing the substrate (14) opposite the cooling box (26) to provide a second heating by radiation.

8. (Amended) A thermal treatment furnace having a reaction chamber wherein a substrate is positioned, characterized in that it comprises a heating and cooling device according to claim 1~~any one of claims 1 to 7~~.

HEATING AND COOLING DEVICE INTEGRATED IN A REACTOR FOR THERMAL TREATMENT OF A SUBSTRATE

Background of the invention

The invention relates to a heating and cooling device arranged in a reactor for thermal treatment of a substrate, comprising:

- first means for heating the substrate to a first temperature, the substrate being positioned on the top face of a plate inside the reaction chamber of the reactor, the first means comprising an electric heating resistor integrated in notches of the plate,
- and second means for cooling the substrate to a second temperature that is lower than said first temperature, the second means being formed by a cooling box situated facing the plate opposite said top face supporting the substrate and movable between a first position separated from the bottom surface of the plate by a gap during the heating phase when the resistor is supplied with power, and a second touching position in contact with said bottom surface when cooling of the plate takes place, the cooling box being formed by a metal body having a good thermal conductivity and equipped with a series of ducts for flow of a heat-conducting fluid.

State of the art

When implementing thermal treatment processes in furnace reactors, obtaining uniformity of the temperature of the substrate to be treated is of paramount

importance.

It has been observed that temperature deviations of a few degrees can have an influence on the quality and properties of the material treated or deposited during the thermal treatment. The heating and cooling devices used in known furnaces do not enable a perfect homogeneity of the temperature at the level of the substrates to be achieved during the heating and cooling operations.

The document EP 0452779 describes a treatment system wherein the heating and cooling means are not mechanically dissociated. The cooling system can not be moved away from the heating system. The assembly is arranged to thermostat the substrate and not to alternately heat and cool or cool and heat the substrate.

The document JP 05263243 describes a cooling box situated facing a rotary plate opposite the top face supporting the substrate. Heating of the plate is performed by means of a resistor, but there are no electromagnetic radiation lamps above the substrate.

The document JP 07045523 describes a treatment device with heating and cooling systems that are not mechanically dissociated. Heating on the rear face of the substrate is performed by infrared lamps, and there are no electromagnetic radiation lamps above the substrate. Cooling or heating of the substrate is achieved by means of a gas that is brought to the required temperature when passing through a heated or cooled part.

The document US-A-5775416 relates to a reactor equipped with a monoblock heating and cooling assembly.

The document US-A-5881208 refers to a RTP apparatus enabling the temperature of a substrate to be controlled. It comprises a heater with a resistor arranged close to the

substrate and a cooling unit arranged as a heat sink.

Object of the invention

A first object of the invention is to achieve an improved heating and cooling device and process enabling optimum homogeneity of temperature to be obtained at the level of the substrate.

A second object of the invention also relates to a thermal treatment furnace equipped with a heating and cooling device enabling a substrate to be heated and cooled rapidly without handling the latter.

The heating and cooling device according to the invention is characterized in that:

- the plate is made of refractory metal,
- an internal lining exhibiting a good thermal conductivity is placed inside the notches of the plate,
- the cooling box is provided with a superficial sheet made of compressible material with good thermal conductivity to obtain a homogeneous thermal contact with the bottom face of the plate,
- the notches of the plate are separated from each other by intermediate transverse members acting as heat transfer means when the cooling box is in the second touching position.

According to a preferred embodiment, the resistor is sunk inside the notches by means of a mass of mineral cement designed to insulate the resistor electrically from the conducting internal lining, the monoblock assembly forming an uninterrupted thermal contact surface. The mineral cement is alumina-based with a high melting point. The resistor can be shielded by means of an insulating sheath and is in this

case sunk directly in the cast metal of the internal lining.

Additional heating means arranged facing the substrate opposite the cooling box can be adjoined to the plate to provide a second heating by radiation. The heating means can be formed by an electric resistor or electromagnetic radiation lamps. To perform processes of the RTP (Rapid Thermal Processing) type, these lamps are halogen infrared radiation lamps. For processes where the temperature is to be minimised when heating is performed, these lamps are of ultraviolet type, for example of mercury or excimer type.

For certain types of substrates having in particular a certain thickness and a low thermal conductivity, it is possible to use two symmetrical plates framing the two opposite faces of the substrate.

According to a heating and cooling process of a substrate arranged in a thermal treatment reactor, wherein the substrate is heated to a first temperature and is cooled to a second temperature that is lower than said first temperature, the following successive steps are performed consisting in:

- first cooling the substrate to the second temperature by means of a cooling box,
- bringing gases in a vacuum or under pressure into contact with the substrate causing condensation in the liquid state,
- increasing the pressure in the reactor as soon as the substrate is covered by a uniform film of liquid,
- moving the cooling box away,
- and heating the substrate rapidly to the first temperature maintaining this temperature for a set time.

Brief description of the drawings

Other advantages and features will become more clearly apparent from the following description of an embodiment of the invention given as a non-restrictive example only and represented in the accompanying drawings, in which:

- Figure 1 is a schematic cross-section view of a heating and cooling plate

according to the invention, the cooling box being represented in the first separated position corresponding to the heating phase of the substrate;

- Figure 2 is an identical view to figure 1, the cooling box being in the second touching position corresponding to the cooling phase of the substrate;
- Figure 3 shows a reaction chamber of a furnace equipped with the heating and cooling device according to figure 1;
- Figure 4 is an alternative embodiment of the device of the figure.

Description of a preferred embodiment

With reference to figures 1 and 2, a heating and cooling device, designated by the general reference 10, comprises a plate 12 made of refractory stainless steel having a flat top surface 13, whereon a substrate 14, in particular made of semi-conducting material, is positioned. Inside the plate 12 there is located a heating means formed by an electric resistor 16 housed in a series of notches 18 separated from each other by intermediate transverse members 20. A thermocouple is placed in a cylindrical hole in the stainless steel part and enables the temperature to be regulated during the heating phases.

A metal lining 22 having a good thermal conductivity covers the internal surface of the notches 18 to optimise the heat transfer from the resistor 16 to the plate 12. This metal lining 22 is obtained for example after a casting operation of an aluminium mass in the hollow part of the plate 12, followed after solidification by a machining operation of the aluminium for formation of the notches 18 for housing the electric resistor 16. The aluminium can naturally be replaced by any other suitable alloy.

The resistor 16 is then sunk inside the notches 18 by means of a mineral cement 24 with high thermal conductivity designed to achieve electrical insulation of the resistor 16 from the metal lining 22. The cement 24 contains for example alumina

Al_2O_3, magnesia MgO, or any other mineral agent with a high melting point, in particular higher than 600°C.

Such an arrangement enables a rapid temperature rise to be achieved when the resistor 16 is supplied with power.

To achieve a high power density per surface unit, an unsheathed resistor 16 insulated by the mineral cement 24 only is used. For lower power densities, it is possible to use a resistor shielded by means of an insulating sheath and sunk directly in the aluminium cast metal without having recourse to the cement.

For high temperatures (above 700°C) or for more rapid temperature rises (from 10 to 300°C per second) than can be obtained with the resistor, infrared radiation lamps placed above the substrate can preferably be used as heating means.

For thermally fragile substrates, the substrate can, when the heating operation is performed, be irradiated by means of UV lamps (conventional or excimer) placed above the substrate. The UV radiation enables the energy received by the substrate to be increased while hardly increasing the temperature of the substrate. In comparison with a process with simple heating, this enables the same result to be obtained at lower temperatures.

A movable cooling box 26 is arranged facing the plate 12 opposite the top surface 13. The box 26 is made of a metal with good thermal conductivity, for example aluminium or copper, and houses a series of ducts 28 for flow of a heat-conducting fluid.

To obtain rapid cooling of the substrate 14 after or before a heating phase, the cooling box 26 has to be brought into contact with the metal transverse members 20

at the bottom part of the plate 12.

The cooling box 26 then acts as a heat sink designed to extract the calories and to cool the plate 12 by conduction via the transverse members 20.

A sheet 30 of small thickness made of compressible material with good thermal conductivity is superposed on the cooling box 26 to obtain a homogeneous thermal contact with the bottom face of the heating plate 12.

The heat exchange between the plate 12 and the cooling box 26 is optimum due to the uninterrupted thermal contact between on the one hand the members 20, the mass of cement 24 and the lining 22, and on the other hand the sheet 30 and the body of the box 26.

The heating phase is illustrated in figure 1, wherein the resistor 16 produces a heat rise of the plate 12 by Joule effect. The substrate 14 bearing on the top surface 13 of the plate 12 is thus heated during a preset time according to the thermal treatment required. The cooling box 26 remains separated from the plate 12 by a gap 32 throughout the heating phase. The maximum temperature is about 700°C with a heat rise rate of 200°C per minute.

In figure 2, rapid cooling of the substrate 14 takes place after the power supply of the resistor 16 has been switched off and the cooling box 26 has come into engagement against the bottom face of the plate 12. The heat-conducting fluid flowing in the ducts can be water or any other liquid. The cooling rate is about 100°C per minute.

The device 10 as a whole enables the substrate 14 to be heated and then cooled rapidly without handling the latter. Homogeneity of temperature at the level of the substrate 14 moreover constitutes an important parameter for the quality and

properties of the material treated or deposited, both during heating and during cooling.

In figure 3, the heating and cooling device 10 is included in a reaction chamber 34 of a treatment furnace 36. The liquid in the ducts of the cooling box 26 flows inside the furnace 36 in a pipe 38 connected to a pump 40 and possibly a heat exchanger 42. According to an alternative embodiment, the heat-conducting fluid can also flow in an open circuit without a heat exchanger.

The plate 12 extends horizontally on a fixed base 44 that confines the bottom part of the reaction chamber 34. The base 44 comprises, on each side of the device 10, an outlet orifice 46 connected to means for creating a vacuum, and an inlet orifice 48 designed for inlet of a gas to the reaction chamber 34.

The wall 50 of the reaction chamber 34 is equipped at the top part with an inspection window 52 that is arranged facing the substrate 14 and is capped by a reflector 54 so as to confine an auxiliary compartment 56. Additional heating means 58 are housed inside the compartment 56 so as to perform a second heating of the substrate 14 by radiation.

The heating means 58 can be formed by an electric resistor or electromagnetic radiation lamps. The inspection window can be replaced by a counter-tube placed around each lamp. The purpose of the counter-tubes or the inspection window is to prevent direct contact between the lamps and the reaction chamber 34 where the substrate 14 is placed. The use of the counter-tubes enables temperature regulation of the substrate when heating takes place to be performed by means of an optic pyrometer that targets the substrate between two counter-tubes by means of a window placed on the top part of the reflector 54.

According to a heating and cooling process, the following successive steps are performed consisting in:

- first cooling the substrate 14 to a second temperature by means of the cooling box 26,
- bringing gases in a vacuum or under pressure into contact with the substrate 14 causing condensation in the liquid state,
- increasing the pressure in the reactor as soon as the substrate 14 is covered by a uniform film of liquid,
- moving the cooling box 26 away,
- and heating the substrate 14 rapidly to the first temperature maintaining this temperature for a set time.

With reference to figure 4, the substrate 14 is placed between two heating and cooling devices 10, 10a having identical structures to that of figure 1.

Such an arrangement is particularly suitable for substrates that are thick or have a low thermal conductivity, and require rapid cooling and heating.

This double symmetrical plate system can also be integrated in a reaction chamber of a thermal treatment furnace.

It is clear that the substrate 14 to be treated can be any support.

CLAIMS

1. A heating and cooling device arranged in a reactor for thermal treatment of a substrate (14), comprising:

- first means for heating the substrate (14) to a first temperature, the substrate (14) being positioned on the top face (13) of a plate (12) inside the reaction chamber (34) of the reactor, the first means comprising an electric heating resistor (16) integrated in notches (18) of the plate (12),
- and second means for cooling the substrate (14) to a second temperature that is lower than said first temperature, the second means being formed by a cooling box (26) situated facing the plate (12) opposite said top face (13) supporting the substrate (14) and movable between a first position separated from the bottom surface of the plate (12) by a gap (32) during the heating phase when the resistor (16) is supplied with power, and a second touching position in contact with said bottom surface when cooling of the plate (12) takes place, the cooling box (26) being formed by a metal body having a good thermal conductivity and equipped with a series of ducts (28) for flow of a heat-conducting fluid,

characterized in that:

- the plate (12) is made of refractory metal,
- an internal lining (22) exhibiting a good thermal conductivity is placed inside the notches (18) of the plate (12),
- the cooling box (26) is provided with a superficial sheet (30) made of compressible material with good thermal conductivity to obtain a homogeneous thermal contact with the bottom face of the plate (12),
- the notches (18) of the plate (12) are separated from each other by intermediate transverse members (20) acting as heat transfer means when the cooling box (26) is in the second touching position.

2. The heating and cooling device according to claim 1, characterized in that the resistor (16) is sunk inside the notches (18) by means of a mass of mineral cement (24) designed to insulate the resistor (16) electrically from the conducting internal lining (22), the monoblock assembly forming an uninterrupted thermal contact surface.

3. The heating and cooling device according to claim 2, characterized in that the mineral cement (24) is alumina-based with a high melting point.

4. The heating and cooling device according to claim 1, characterized in that the resistor (16) is shielded by means of an insulating sheath and is sunk directly in the cast metal of the internal lining (22).

5. The heating and cooling device according to one of the claims 1 to 4, characterized in that it comprises additional heating means (58) arranged facing the substrate (14) opposite the cooling box (26) to provide a second heating by radiation.

6. The heating and cooling device according to claim 5, characterized in that the heating means (58) can be formed by an electric resistor or electromagnetic radiation lamps.

7. The heating and cooling device according to claim 1, characterized in that the substrate (14) is placed between two plates (12) arranged symmetrically in the reaction chamber (34) with respect to the mid-plane passing through the substrate (14).

8. A thermal treatment furnace having a reaction chamber wherein a substrate is positioned, characterized in that it comprises a heating and cooling device according to any one of the claims 1 to 7.

9. A process for heating and cooling a substrate (14) arranged in a thermal treatment reactor, wherein the substrate is heated to a first temperature, and is cooled to a second temperature that is lower than said first temperature,

characterized by the following successive steps consisting in:

- first cooling the substrate (14) to the second temperature by means of a cooling box (26),
- bringing gases in a vacuum or under pressure into contact with the substrate (14) causing condensation in the liquid state,
- increasing the pressure in the reactor as soon as the substrate (14) is covered by a uniform film of liquid,
- moving the cooling box (26) away,
- heating the substrate (14) to the first temperature maintaining this temperature for a set time.

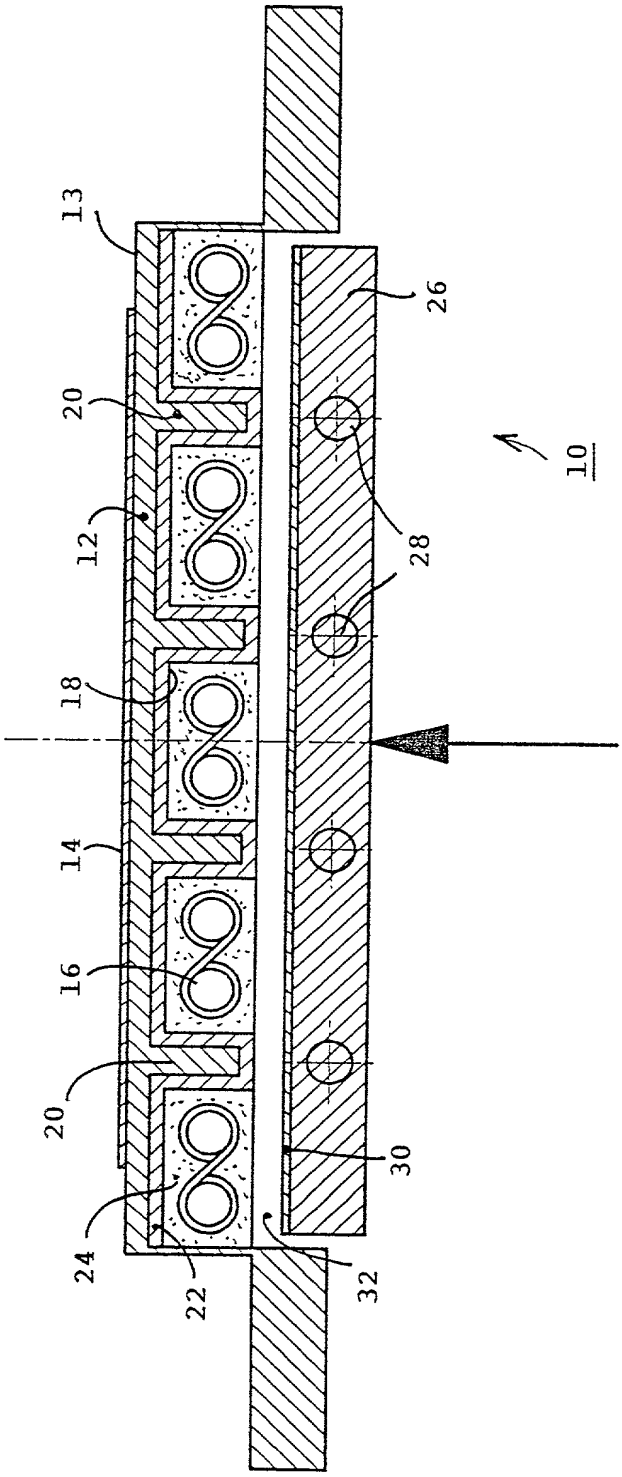


FIG 1

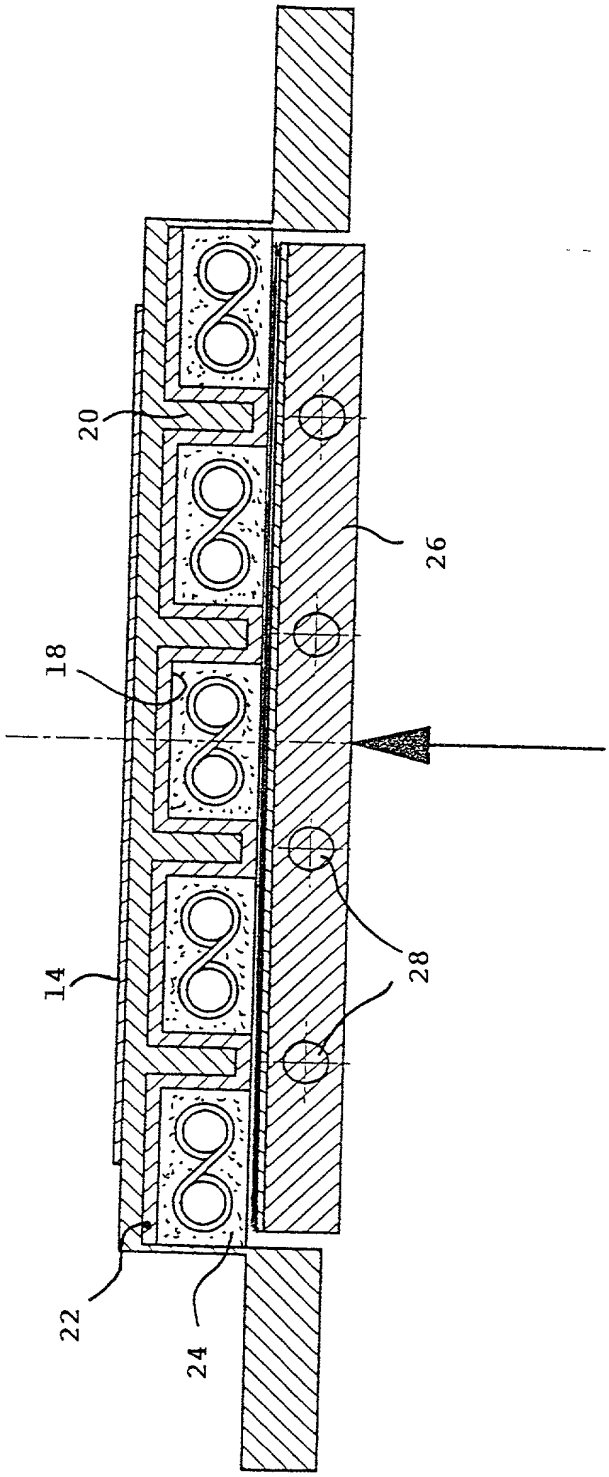


FIG 2

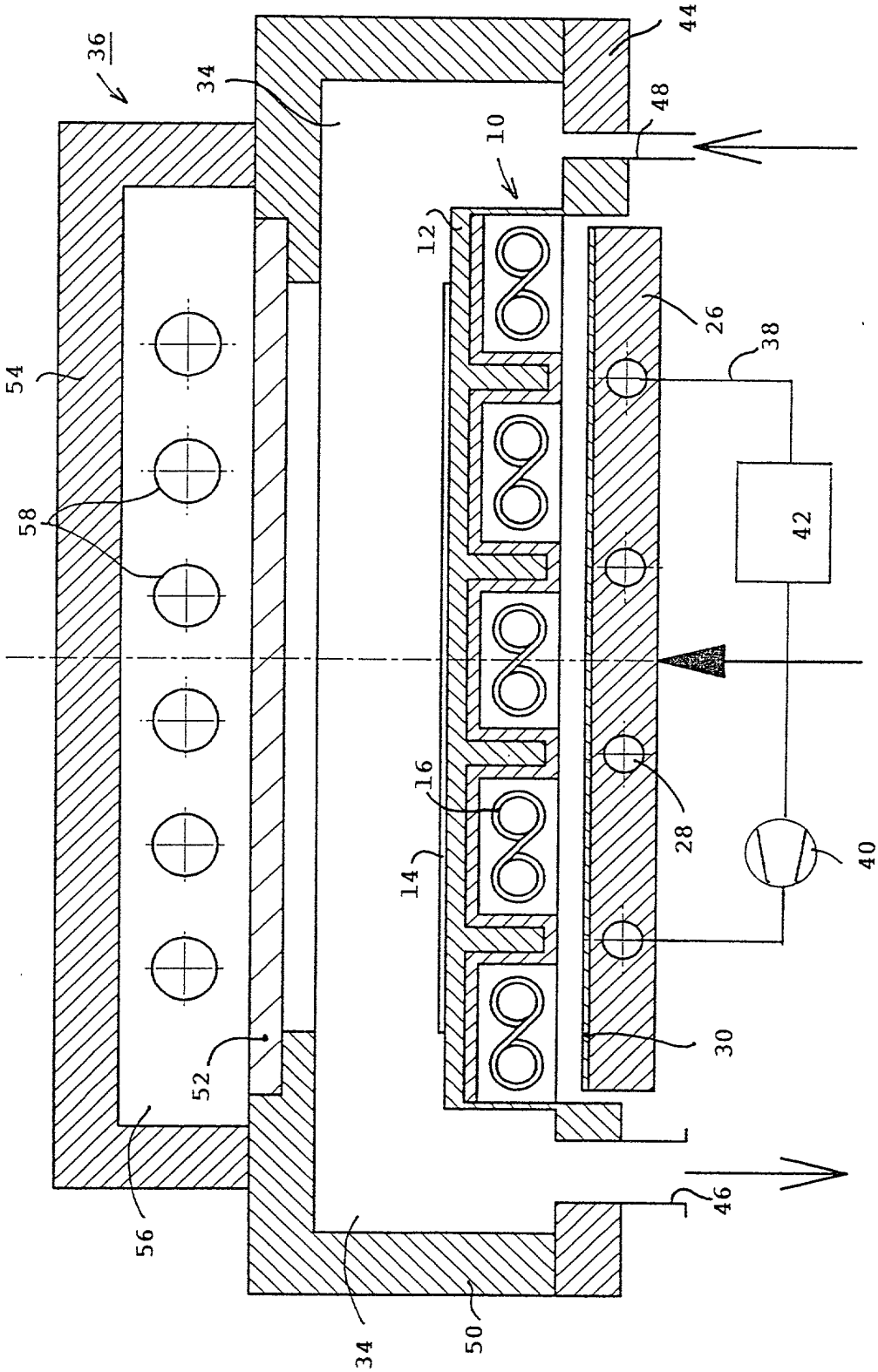


FIG 3

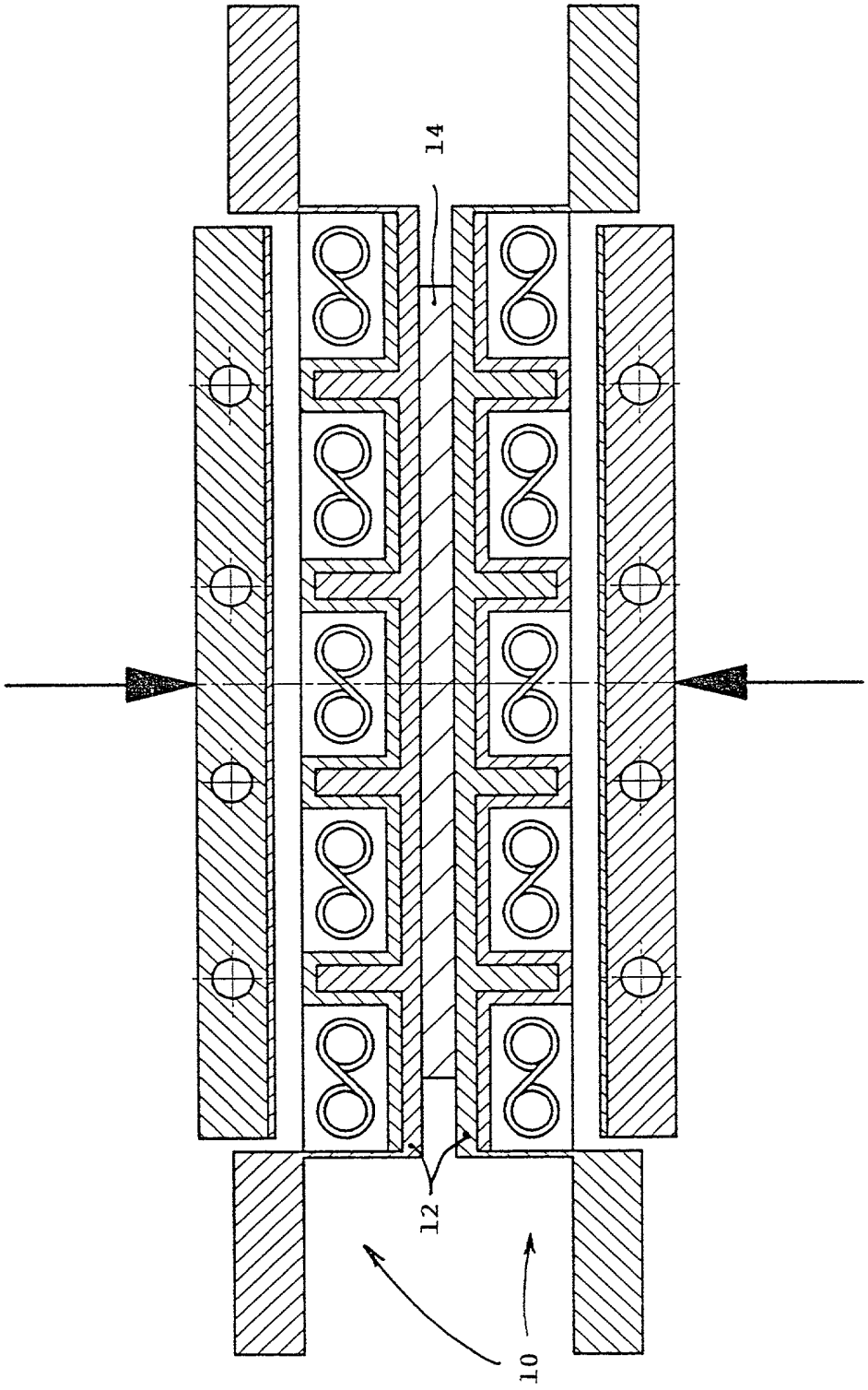


FIG 4

Docket No.: _____

DECLARATION AND POWER OF ATTORNEY UNDER 35 USC §371(c)(4) FOR PCT APPLICATION FOR UNITED STATES PATENT

As a below named inventor, I hereby declare that:

my residence, post office address and citizenship are as stated below under my name;

I verily believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought, namely the invention entitled: **Integrated heating and cooling device in a reactor for thermal treatment of a substrate.**

described and claimed in international application number **PCT/FR00/00946** filed **12 APRIL 2000**.

I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations §1.56. Under Title 35, U.S. Code §119, the priority benefits of the following foreign application(s) filed within one year prior to my international application are hereby claimed:

French **Patent Application n° 99 04680**
Filed **on 12 APRIL 1999**

The following application(s) for patent or inventor's certificate on this invention were filed in countries foreign to the United States of America either (a) more than one year prior to my international application, or (b) before the filing date of the above-named foreign priority application(s):

NONE

I hereby appoint the following as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent Office:

James A. Oliff, Reg. No. 27,075; William P. Berridge, Reg. No. 30,024; Kirk M. Hudson, Reg. No. 27,562; Thomas J. Pardini, Reg. No. 30,411; and Edward P. Walker, Reg. No. 31,450.

ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT TO OLIFF & BERRIDGE, P.O. BOX 19928, ALEXANDRIA, VIRGINIA 22320, TELEPHONE (703) 836-6400.

I hereby declare that I have reviewed and understand the contents of this Declaration, and that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1 Typewritten Full Name of Sole or First Inventor: **Pierre** (Given Name) _____ (Middle Initial) **DUCRET** (Family Name)

2 Inventor's Signature _____

3 Date of Signature **4 SEPTEMBER 2001**

Residence **CROLLES** (City) _____ (State or Province) **FRANCE** (Country)

Citizenship **FRENCH**

Post Office Address (Insert complete mailing address, including country) **452 rue des Sources, cidex 112**
F-38920 CROLLES, France

Note to Inventor: Please sign name on line 2 exactly as it appears in line 1 and insert the actual date of signing on line 3.

IF THERE IS MORE THAN ONE INVENTOR USE PAGE 2 AND PLACE AN "X" HERE XX

(Discard this page in a sole inventor application)

1 Typewritten Full Name of Joint Inventor: Hervé (Given Name) | Middle Initial | GUILLON (Family Name)
2 Inventor's Signature: [signature]
3 Date of Signature: 4 September 2001
Residence: CROLLES (City) | State or Province | FRANCE (Country)
Citizenship: FRENCH
Post Office Address (Insert complete mailing address, including country): 452 rue des Sources, cidex 112
F-38920 CROLLES, FRANCE

1 Typewritten Full Name of Joint Inventor: Given Name | Middle Initial | Family Name
2 Inventor's Signature:
3 Date of Signature:
Residence: City | State or Province | Country
Citizenship:
Post Office Address (Insert complete mailing address, including country):

1 Typewritten Full Name of Joint Inventor: Given Name | Middle Initial | Family Name
2 Inventor's Signature:
3 Date of Signature:
Residence: City | State or Province | Country
Citizenship:
Post Office Address (Insert complete mailing address, including country):

1 Typewritten Full Name of Joint Inventor: Given Name | Middle Initial | Family Name
2 Inventor's Signature:
3 Date of Signature:
Residence: City | State or Province | Country
Citizenship:
Post Office Address (Insert complete mailing address, including country):

1 Typewritten Full Name of Joint Inventor: Given Name | Middle Initial | Family Name
2 Inventor's Signature:
3 Date of Signature:
Residence: City | State or Province | Country
Citizenship:
Post Office Address (Insert complete mailing address, including country):

Note to Inventor: Please sign name on line 2 exactly as it appears in line 1 and insert the actual date of signing on line 3.

This form may be executed only when attached to the first page of the Declaration and Power of Attorney of the application to which it pertains.